Marine Physical Laboratory

Bottom Reverberation Experiment Planning and Data Analysis

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William S. Hodgkiss

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Abstract

The major bottom acoustics experiment of the ONR Acoustic Reverberation Special Research Program (ARSRP) was carried out in July 1993. Detailed planning for this experiment was carried out by the Acoustics Experiment Working Group and involved coordinating the activities of three ships - the M/V Cory Chouest, the R/V Alliance, and the R/V Knorr. Hardware deployed during the experiment included near-bottom, vertical arrays and recording capsules for collecting bistatic scatter. After the experiment, these data were transcribed, distributed, and an assessment made of their quality. Analysis and modeling has been carried out using both the vertical array data as well as horizontal towed array data which also was collected during the experiment

Research Objective

The objective of this project was to participate in planning the July 1993 ONR Acoustic Reverberation Special Research Program (ARSRP) bottom reverberation experiment, distribute the data collected by the near-bottom, vertical arrays and recording capsules, and analyze both vertical array and horizontal towed array data from the experiment in an

effort to understand the interaction between low frequency, low grazing angle acoustic energy and the sea floor.

Research Summary

The ARSRP bottom reverberation experiment was carried out in the vicinity of the Mid-Atlantic Ridge in July 1993. Three ships participated in the experiment - the M/V Cory Chouest, the R/V Alliance, and the R/V Knorr. W. Hodgkiss was Chief Scientist on the R/V Knorr as well as Chair of the Acoustics Experiment Working Group which planned the experiment. The Cory Chouest deployed a vertical line source array and a horizontal line receive array, the Alliance deployed a flextensional source and a horizontal line receive array, and the Knorr deployed both the vertical, near-bottom reverberation arrays and recording packages as well as the DTAGS (Deeply Towed Acoustics Geophysics System).

The 64-element, large dynamic range, acoustic arrays and autonomous recording capsules deployed from the R/V Knorr were designed and fabricated by MPL for the experiment. A detailed discussion of the array hardware design is contained in [1]. The bottom reverberation experiment was very successful and all three ships collected a substantial amount of both monostatic and bistatic reverberation data. Immediately after the experiment, the integrity of the data collected by the near-bottom, vertical arrays was documented in a quick-look analysis of the first 5 min of every data tape (each 8 mm tape recorded approximately 3 hr 20 min of data). These results are contained in [2].

MPL had responsibility for distributing the data collected by the near-bottom, vertical arrays. This involved carrying our low- level quality checks on the raw data (time stamp integrity, etc.), transcribing into an archival data format (SIO data files), and copying the tapes for other experiment participants. Documentation from the low-level quality checks is contained in [3].

As an aid to the analysis of the data, MPL generated half-hour, time-evolving spectral analysis plots (grams) of the entire data set collected by the near-bottom, vertical arrays [4]. These have proven quite valuable in understanding various aspects of the data - specifically, confirming which wavetrain was in the water at any given time.

The modeling of bistatic scatter is an integral part of the data analysis process. Our reverberation modeling studies have been based primarily on the UMPE/PEREV model. The UMPE model is a broadband PE/SSF code developed at the University of Miami and contains the complete full-wave physics of forward scatter from a rough sediment layer of variable average depth and a rough subsediment or bottom interface. UMPE is documented in [5] and a modification of UMPE to efficiently calculate acoustic particle velocity is reported in [6]. The theoretical foundation for the PE reverberation (PEREV) model developed by Tappert and incorporated into the UMPE code is that of a multiple forward scatter / single backscatter model and includes the definition of a wave scattering strength that depends on the 2D spectrum of the interface roughness. The scattering physics incorporated into PEREV is discussed in [12]. One desirable upgrade has been to enhance the UMPE/PEREV code to carry out bistatic calculations. Another area of work has been to implement broadband computations in order to investigate multipath pulse propagation effects and the limits multipath imposes on our ability to resolve individual discrete reverberation events. Lastly, UMPE recently has been upgraded to include azimuthal coupling which makes it a fully 3-D forward propagation model. Combining this new UMPE with PEREV has enabled examining the effects of azimuthal coupling on bottom reverberation [7].

A major goal of the data analysis effort has been to produce a successful mapping of reverberation returns onto bathymetric features. In a gross sense, this has been achieved for both monostatic and bistatic data. Using the UMPE/PEREV code to make model predictions, we have been able to verify the strong correlation between bottom insonification and high levels of reverberation. Comparisons have been made between UMPE/PEREV predictions and data taken during the July 1993 bottom reverberation experiment. Analysis of the horizontal towed array data appears in [8-9] and analysis of the near-bottom, vertical array data appears in [10-11]. Examples of UMPE/PEREV predictions and data analysis results from both the near-bottom vertical array and horizontal towed array data are given in [12].

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